

A PARADIGM SWITCH IN URBAN STORMWATER MANAGEMENT: Achieving Integrated Strategic Approaches; The Belo Horizonte Example

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ABSTRACT

The paper explores regulatory regimes and institutional structures to support integrated urban stormwater management (IUSM) in sustainable, cost-performance based approaches as developing within the context of the example provided by Belo Horizonte in Brazil. It is argued that the paradigm switch to a sustainable infrastructure will only be effected given a supporting national strategic policy and enabling legislation, nested in appropriate municipal level organisational delivery structures. Inter and intra-organisation capacity building and the development of human resource capabilities are considered as being pre-requisites as well as a better understanding of environmental responses at varying planning and impact scales. Given an appropriate national and local framework, management approaches for the control of urban stormwater can be largely incorporated into supplementary supporting measures to guiding national strategic policy and regulation.

Key words: integrated urban stormwater management; learning alliances; institutional drivers; capacity building; stakeholder involvement.

1. INTRODUCTION

Despite an increasing technical knowledge and regulatory awareness of the principles of sustainable urban stormwater management, as evidenced by the plethora of national and state best practice manuals published in North America, Europe and Australia, implementation of best practice on the ground still remains uncertain and problematic (Chocat *et al.*, 2004). This technological inertia has been reinforced by impediments related to socio-political uncertainties and difficulties. Such institutional inertia may be much more significant than issues of technology in pushing forward sustainable urban drainage targets (Ellis, 1995). It is clear that new approaches and attitudes are required in order to successfully address the challenge of integrated urban stormwater management (IUSM). However, in contrast to the approaches adopted for conventional and centralised sewered urban drainage systems, there can be no “one-size fits all” solution. Neither can there a “best solution”, but rather a choice of feasible technical, legal, organisational and socio-financial alternatives (Starkl and Brunner, 2004).

In addition, it is not possible to resolve the issue of stormwater control without recognition of the interactions between diffuse rainwater-runoff, point wastewater discharges, receiving water quality and urban land management (Lawrence *et al.*, 1999). In this respect, IUSM can be defined as a structured and coherent master planning process to concurrently evaluate the opportunities to improve the management of surface water and drainage services within the context of urban landuse planning, and in ways which are consistent with wider strategic catchment and river management objectives. This requires a combination of a robust, multi-objective framework, integrating state/federal and local planning with strategic water policy and undertaken within a total catchment approach (Marsalek *et al.*, 2001). This template for IUSM must also consider prevailing socio-economic conditions and institutional arrangements as well as the operating legislative framework. The priority objectives should be to avoid or minimise increased flooding and pollution, to increase use efficiency and support local environmental quality-of-life.

The technical problems of, and solutions for, IUSM require engagement with a complex array and hierarchy of administrative, legislative, political, institutional, social, economic and cultural levels and issues. A generic objective of an integrated, holistic approach is to deliver more effective provision of urban stormwater services carrying minimum risks and improved sustainability within the context of wider strategic, catchment-based water and land management planning. This is the core mission of the 6th EU Framework project, “*Sustainable Water Management to Improve Tomorrow’s Cities’ Health*” (SWITCH; www.switchurbanwater.eu) which is a consortium of 32 partners drawn from 13 countries. SWITCH calls for a paradigm shift in urban stormwater management to convert “*ad-hoc*” actions (primarily problem and incident driven), into a coherent and consolidated, forward-looking approach which is more sustainably driven. The focus of the innovative approach is centred in 9 demonstration cities through the formation of Learning Alliances (LAs) whose work is considered as comprising the central mechanism for affecting holistic integrated change, with its emphasis firmly based on capacity-building networks. This paper focuses on the formation, responsibilities, actions and emerging outcomes of the Belo Horizonte LA in Brazil to illustrate the principles and requirements, as well as challenges, of developing operational organisational structures to implement fundamental changes in urban drainage infrastructure.

2. LEARNING ALLIANCE PLATFORMS

Central to the concept of Learning Alliances (LAs) is the recognition that many approaches and methodologies fail to “make the leap” from research to practice, together with an appreciation that the introduction of new tools and frameworks into widespread use requires the commitment of a wide range of stakeholders drawn from a variety of organisations. The development of LAs aims to address both these issues by bringing together relevant representatives and organisations from a range of public, private and civil sectors e.g industry, regulators, utilities, developers, NGOs, researchers, financial/insurance services and public advocacy groups, to foster and facilitate integrative collaboration and the scale-up of new and innovative approaches (Moriarty *et al.*, 2005). LAs typically consist of a series of structured platforms, at different institutional levels e.g national, regional/river basin, municipality, district, local community etc., designed to break-down barriers to both horizontal and vertical information sharing and facilitate strategic policy decisions.

Thus the innovative aspects of SWITCH are not the development or implementation of new research tools and activities *per se*, but rather the mobilisation, integration and delivery of best practice approaches and technologies within and across different sectors of the urban water management cycle. Such water resource partnerships exist in many countries and in their simplest form, LAs represent a series of linked strategic partnership platforms existing at different institutional levels and created with the specific aim to bring together collaborative support forums for the critical decision-making stakeholders involved in urban drainage infrastructure. The innovation in the LA concept lies in the structured linking of urban land and water management, together with the empowerment of local municipality delivery structures and mechanisms.

3. NATIONAL STRATEGIC POLICY AND MUNICIPAL ORGANISATION

3.1 *The Drivers for Integrated Approaches*

Belo Horizonte (BH) is the planned capital city of the Brazilian state of Minas Gerais and has a total population of 2.2 million and an average population density of 6,900 inhabitants/km². BH has a separated sewerage system but mis-connections are common resulting in highly polluted receiving water bodies both within and downstream of the urban area. Approximately 92% of the population are connected to the wastewater sewerage system but mainly due to lack of interceptor lines, currently only 38% of wastewater flows are treated. About 200,000 inhabitants, many of whom live in the favelas, have no sewage or stormwater collection facilities. Since the early 1990s, BH has possessed a

systematically structured process of urban and environmental planning which acknowledged social inclusion and public participation. However, sanitation (and water supply), under contracted concession, was prior to 2006 the responsibility of a company (COPASA) but since then has shared responsibilities with the state (~60%) and municipality authorities (~10%), retaining only some 30% of powers within the private sector. The pre-2006 organisational structure tended to have a technocratic and semi-autonomous authoritarian framework for decision-making (Heller, 2007). This meant that the technical and institutional organisation of water and sanitation systems (WSS) did not always directly respond to the directives of urban policy which fell under local municipality authority (PBH) and WSS was separated from stormwater management. The increase in poor urban areas as well as illegal industrial discharges, has resulted in increases in illegal potable water, wastewater and stormwater connections and made it difficult for the company to identify and combat such illicit sources as well as jeopardising charging regimes. In addition, such contaminated outflows had significant impacts for both public and receiving water health as well as increasing the flood risk.

The Brazilian state company model for urban water/wastewater resource management was originally established in the 1970s but was revised in 1993 by a water sector modernisation programme (PMSS) which contributed to the substantial improvement of urban water management at institutional, legal, managerial and commercial levels. This PMSS programme introduced not only new institutional models (such as private water companies) but also new financing mechanisms and legislative regulation as well as shared management approaches. The formation of a Federal National Water Agency (ANA) and National Council of Water Resources (CNRH) reinforced the importance of the river basin as the basic water planning unit for national strategic flood and quality objectives. However, institutional restructuring did not always fully take into account that landuse regulation was the prerogative of the municipalities or that many urban sub-catchments could only be effectively regulated through the local administrative domain (Britto and Silva, 2006). The municipality provided the appropriate legal and administrative framework under the new PMSS laws to develop urban policy as well as having management and regulatory responsibility for compliance with water/wastewater concession requirements.

The Ministry of Cities therefore promulgated a new environmental sanitation law (Law 11445/2007) based on the concept of "*saneamento ambiental*" or integrated water resource and waste management. The law defines a hierarchy of three major levels of planning (national, state and municipal) with each level required to identify the services to be included within their water, wastewater and rainwater sanitation plans. These plans must be compatible with the national/state basin plans and in the case of the municipal-level plan, with the master urban development planning for the municipality. National Law 11445 gives the concession of water use right as a mandatory instrument for water withdrawal for drinking water supply as well as urban effluent disposal to receiving watercourses. By highlighting this concession as an instrument for urban water management, the law reinforces the link between the policy of "*saneamento ambiental*" and that of water resource management as contained in the earlier Law 9433/1997. This latter statute required the municipal executive to make efforts to integrate local policies on environmental sanitation, landuse, soil and environmental conservation with the strategic water resource policies of federal and state authorities. However, this integrated planning and management philosophy is far from being complete or operational. Law 9433 also gave statutory rights for water use charges, with taxes obtained for water withdrawal and effluent disposal being theoretically available to fund actions for the reduction of both urban CSOs and non-point pollution. However, resources are likely to be primarily allocated to wastewater treatment rather than to diffuse urban runoff problems. In addition, the recent consortium Law 11107/2005 enables municipalities to collaboratively organise sanitation services on a regional basis, which might in the future facilitate the implementation of IUSM on a larger catchment scale.

National/federal directions and associated enabling legislation have therefore provided the contextual drivers in terms of the formulation of strategic policy directions. These have been framed by the need to achieve substantial improvements in environmental infrastructure and land use capacity as well as a political desire to achieve social participation in service provision and delivery. However,

it is probably the political willingness and administrative commitment at the local municipal level to seek out more effective intra- and inter-institutional structures to deliver more integrative approaches for urban land and water management that is providing the most influential driver.

3.2 The Belo Horizonte Learning Alliance Structure

The agreement to form a Learning Alliance in Belo Horizonte therefore occurred at an opportune time, as in 2004, in anticipation of the new law, the urban water department (SUDECAP) of the local municipality (PBH) coordinated the establishment of a special committee (created by a local municipal bye-law) to consider more integrated urban water and wastewater policies and to develop a masterplan for future implementation. The environmental sanitation committee (COMUSA) was therefore already committed to address priority policies and seek new approaches for “*saneamento ambiental*” or integrated water resource and solid waste management and were charged with responsibility to develop a Municipal Sanitation Plan (PMS). Figure 1 illustrates the Belo Horizonte LA proposed structure which will draw together four distinct tiers of governance and institutional organisations.

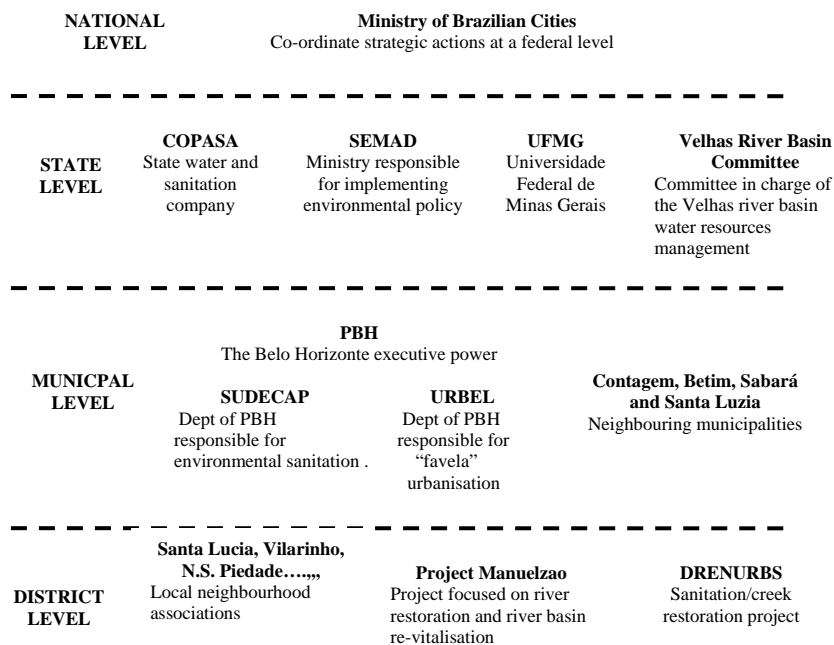


Figure 1. The Belo Horizonte LA: Connected Stakeholder Platforms

The new “*saneamento ambiental*” bill clearly places administrative oversight of urban water services at the city council level, through which participation in and responsibility for integrated water and sanitation services will reside. Amongst their functions, city councils will both develop and advise on the strategies and priorities for their municipal water and sanitation plan. This will subsume allocation of priority investment, the definition of cross-subsidisation and social aid as well as advise on service delegation such as might be contracted to companies such as COPASA. In addition, they will have to coordinate with adjacent city councils under consortium agreement and also work in association with relevant bodies such as the Health, Environment and Urban Planning Councils. The federal bill also puts in place a general political directive for public participation in services management at the local municipal level .

The PMS plan confirmed the “*water basin as the planning unit for actions related to sanitation services*” which re-iterated a previous Drainage Master Plan (PDD). The development of such sanitation plans in accordance with national policy has placed BH as a national reference, and the municipality is viewed as a “champion” of integrated urban environmental approaches within Brazil (Costa and Costa, 2007). It is this promulgative attitude at the local municipal level to innovative

directions, and administrative willingness to seek out and implement appropriate supporting institutional structures, that provides a fundamental key in the initial steps towards a new stormwater drainage paradigm. The driving national regulation and accompanying legislation under Law 9433 has provided the enabling key which allows the BH municipality to introduce charges for stormwater management services based on impermeable area together with the possibility to implement source control measures. Such drainage taxes might be used to sensitise both developers and residents to the requirement for reduction in runoff volumes and diffuse pollution (Nascimento *et al.*, 2005) and the adoption of such charges is currently under evaluation within the context of the development of the stormwater masterplan.

4. INSTITUTIONAL CAPACITY BUILDING

Figure 2 illustrates the institutional and organisational structures that have been established in BH under the new national Law 9011/2005. The municipal executive planning policy directions are to be provided by SMURBE, who will articulate the strategic definition and implementation of urban environmental policy. SMURBE has immediate responsibility for integrating the work of the lower level organisations responsible for drainage and flooding, solid waste, land use planning and environmental protection/enhancement (COMPUR, COMAR, COMUSA). This second level organisational tier has responsibility for service delivery. The BH municipal authority has also established a parallel executive organisation having direct responsibility for receiving watercourse

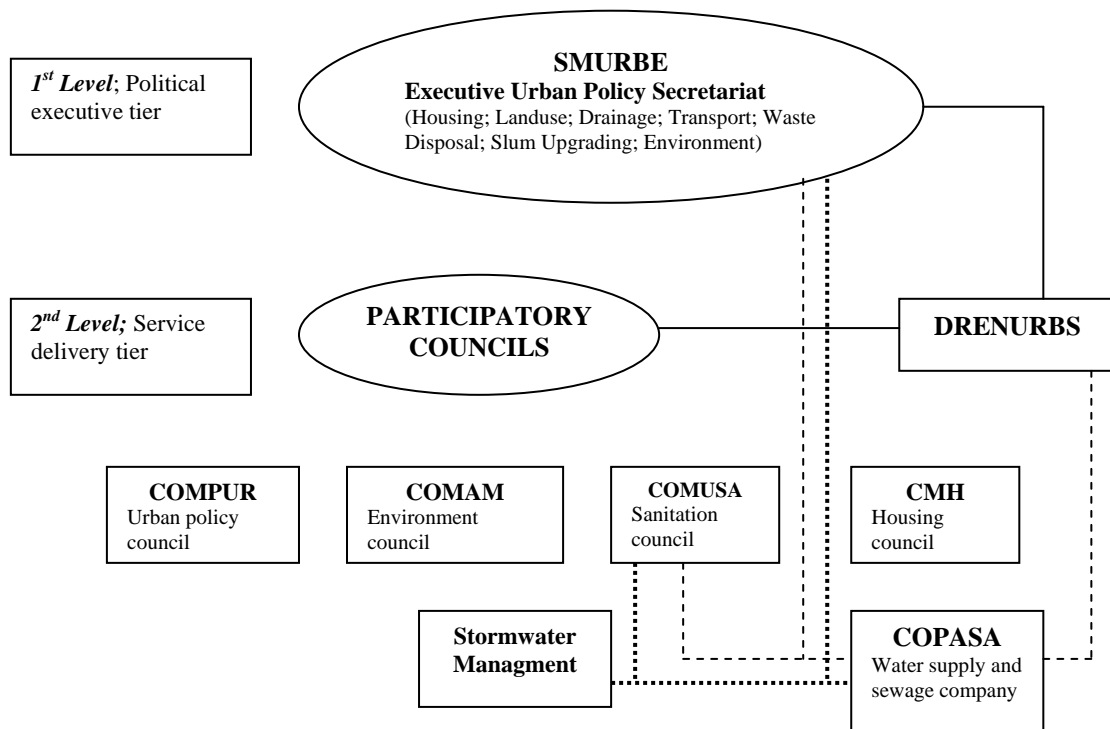


Figure 2. Belo Horizonte Municipal Administrative Structures.

restoration (over a 177 km² area), which also incorporates responsibility for improvement of housing conditions in flood prone areas (DRENURBS). However, the priority policy emphasis of the DRENURBS programmes will be on environmental quality-of-life issues. This organisational group will need to maintain a close integrated relationship with the other second level participatory councils if it is to effectively achieve its objectives over the next 15 years.

The capacity of the BH municipal authority to facilitate integrated urban stormwater management will depend on the internal institutional capacity and effectiveness of the new organisational

arrangements following on from the national directive and municipal reforms. The re-structuring and strengthening of the local organisational capacities must work at both intra-and inter-organisational levels. At the intra-organisation level, there is already a clear political willingness for sustainable action which will need to be formulated into coherent corporate policy supported by internal inter-disciplinary committees and resources. A delegated officer and/or group empowerment for action will need to be codified and a competency and training in stormwater management developed. At the inter-organisational level, there will be a need for the establishment of active and extended stakeholder networks in order to promote task-sharing responsibilities and to develop experience and confidence in inter-agency collaboration. This may involve the establishment of appropriate Advisory Groups and staff/contractor training in technical design, signage campaigns, demonstration sites, small/medium size industry awareness raising campaigns, developer liaison activities, community workshops on urban drainage, water challenge competitions to track/reduce water usage rates, information leaflets and brochures, local education programmes (e.g walking and nature trails) etc. These actions and activities at the lowest municipal tiers are essentially concerned with the development of human resource capabilities. However, the measures contained within these various organisational programmes include a range of accessory approaches which would also be appropriate under the EU Water Framework Directive (WFD) Supplementary Measures for diffuse pollution management. Some of the actions could be incorporated into General Binding Rules (GBRs) as national/federal guidance for “controlled” urban landuse activities such as the abatement of mis-connections, use of source control drainage for specific discharges such as vehicle washdown and steam cleaning, chemical storage etc.. Other activities would be more appropriately addressed at the local municipal level by bye-laws and under landuse planning and drainage guidance.

5. LIMITATIONS AND CHALLENGES

The traditional separation and semi-autonomy of local authority sectors has the potential to be overcome in Belo Horizonte, as well as in many other cities around the world, by the introduction of integrated organisational structures. Single-disciplinary functional compartments create communication barriers, lack of cohesion and accountability as well as a dislocation between management, service delivery and operational maintenance. The new BH organisational framework will build on and improve the horizontal and vertical flows of information and skills across municipality sectors. Stormwater management can then be more holistically and coherently integrated with runoff and water quality issues of the wider urban catchment(s) and with urban land planning processes. Major elements currently missing from the existing stormwater management process are a detailed understanding of urban ecosystem health and the identification of appropriate abatement strategies based on multiple root causes and which result from a combination of acute and chronic impacts.

Long term funding will undoubtedly comprise a major challenge and may constitute the ultimate limiting factor to an integrated approach as well as the need for detailed inventories on which policy implementation can be reliably and robustly based. Integrated stormwater management will also need to ensure that the interdependent aspects of water quantity and quality should be concurrently considered in order to achieve effective and sustainable solutions. Greater weighting might need to be applied to works that achieve multiple objectives, source control and stormwater re-use. These aspects will demand technical training, resource development and community involvement. The national network on environmental sanitation training (ReCESA) is a central government initiative intended to help build human resource capacity in the sanitation sector, including the urban drainage field. The network training programmes will involve both public and private participation and the objective of the initial 2007-08 phase is to develop appropriate training materials. There are opportunities for future EU SWITCH activities to support not only the LA training workshops but also reinforce ReCESA actions in this resource building domain. Nevertheless, urban water managers will certainly struggle to achieve a full and better understanding of the relationships and priorities of a range of controlling parameters including flood risk, water quality, ecosystem and riparian health,

drainage infrastructure etc.. In addition, experience will need to be developed on approaches and tools to objectively evaluate the relative benefits and risks of potential control and treatment options.

Specific objectives, targets and performance-based criteria will need to be set, monitored and evaluated for a variety of biophysical, ecological, social and economic parameters. The interfaces between the science of urban catchment health, ecosystem functioning, urban land planning and strategic policy decision-making will present major challenges for the new organisational structures. Objective setting, option evaluation and priority action strategies will facilitate adaptive management for sustainable urban stormwater management. The flexibility of adaptive approaches however, will be impaired if there is a lack of benchmarks and baseline information on catchment dynamics and ecosystem response. A key element in the innovative organisational framework must be the recognition of the differing regimes and impacts of storm events (Davies and McManus, 2004). Figure 3 illustrates that sustainable integrated stormwater management will need to plan for three major categories of storm events within the hydrologic spectrum, each of which will have different impacts on the biophysical, social and economic environment.

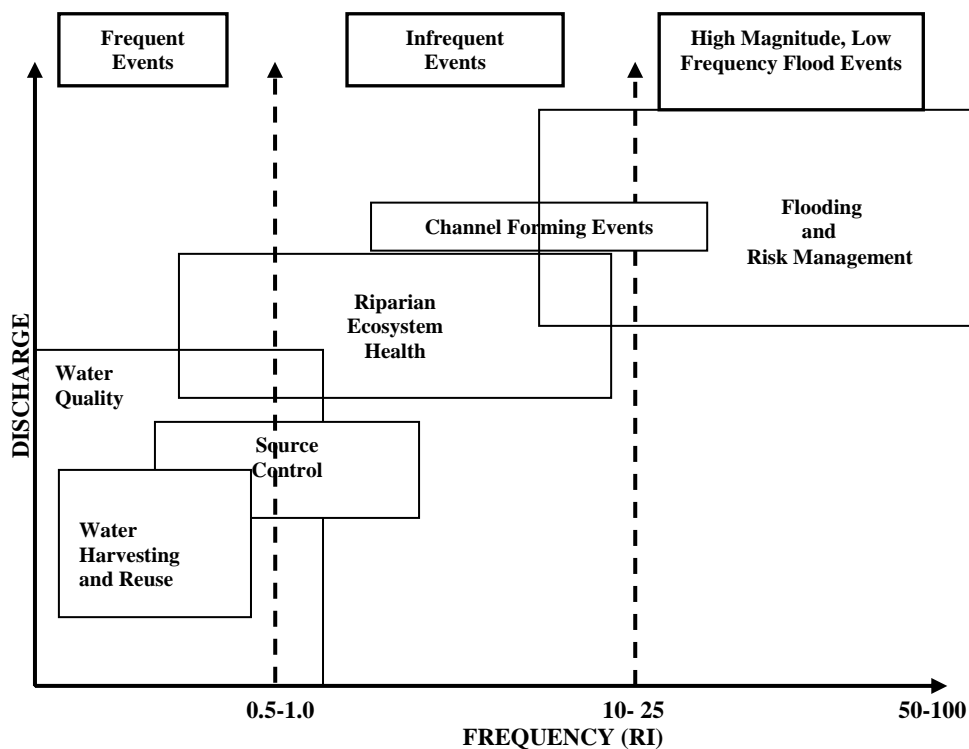


Figure 3. Stormwater Management Planning Scales and Issues.

This tri-level consideration represents a significant shift from conventional planning processes such that frameworks intended to address major flood risk for example, should also consider receiving water health and ecosystem functioning, land use capacity and potential, social/community values and expectations as well as cost viability. In addition, proposed controls and management approaches should also be compatible with municipal, regional and catchment planning objectives

An appropriate organisational framework must identify and develop relevant management objectives and targets for:

- *aquatic environmental values*; receiving waterbody health covering both surface and groundwater, ecosystem stability, channel form
- *terrestrial environmental values*; riparian zone, bankside vegetation, open space use etc.
- *social environmental values*; aesthetics, recreation, local community involvement, disturbance
- *economic environmental values*; flood damage, public health, water demand.

Each of these environmental values must be related to specific flow regime levels and to water quality effects on both short (acute) and long term (chronic) time spans. An evaluation of these environmental values and controlling regime factors will assist in the determination of the principal waterbody stressors in order to aid the prioritisation of “hotspots” and to effectively target scarce resources.

6. CONCLUSIONS

It is essential that urban land and water management be addressed in an integrated manner and within a catchment framework if a successful paradigm “switch” for diffuse urban stormwater management is to be achieved in a sustainable cost-performance way. This requires a strategic national framework and enabling legislation to be in place and that efficient collaborative organisational delivery structures are established at the local municipal level. Institutional capacity building at these local/regional levels can then be based on the tripartite cornerstones of directive reform, inter and intra-organisational strengthening and human resource development. Most regulatory management measures can then be implemented by non-registration GBRs but this will also require the consistent and on-going implementation of local and sector-oriented awareness campaigns. However, such IUSM approaches also need to be supported by an appropriate alignment of national/federal economic drivers in order to achieve consistent, progressive and equitable regulatory and management regimes. There also needs to be a balance of roles, powers and objectives in the water governance structure between national, state and municipal levels as well as between public and private sectors, in order to achieve an effective neutrality in decision-making.

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